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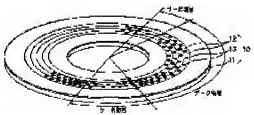
(54) MAGNETIC RECORDING MEDIUM AND MANUFACTURE THEREOF

(57)Abstract:

PROBLEM TO BE SOLVED: To attain the magnetic recording of large capacity capable of simultaneously 1 realizing a high linear recording density and a tracking density.

SOLUTION: The storage area of a minimum unit for recording/ reproducing each track is composed of isolated magnetic material cells 13 buried in minute holes which are arrayed at prescribed positions on anodized aluminum layers 12 being a non-magnetic material on the surface of a medium 10 and also each track is divided to a data area for recording information and a servo area arranging a servo signal for detecting the position of the track. Then, the magnetic material cells 13 in the servo area are arranged on a concentric circle shifted by a half from the track of the data area, alternately at two kinds of intervals different for every adjacent tracks while being not the integral multiple of the arranged intervals of the magnetic material cells 13 in the data area.



DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]The enlarged model figure showing an example of the embodiment of the magnetic recording medium of this invention
[Drawing 2]The lineblock diagram of the recording and reproducing device to the magnetic recording medium of this invention
[Drawing 3]The explanatory view showing the relation between magnetization shape and a reproducing output
[Drawing 4]The manufacturing process figure of the magnetic recording medium of this invention
[Drawing 5]The manufacturing process figure of La Stampa used for manufacture of the magnetic recording medium of this invention
[Drawing 6]The explanatory view of an example of the regenerative signal based on arrangement and this of the magnetic substance cells on a magnetic recording medium
[Drawing 7]The explanatory view of an example of the position information based on the arrangement and this of a servo pattern to data tracks
[Description of Notations]
A magnetic recording medium, 11:substrate, 12:alumite layer, 13 : 10: Magnetic substance cells, A magnetic head, 22:spindle, 23:actuator, 24 : 21: A record reproduction circuit, An error amplifier, 26:switching circuit, 27:servo amplifier, 28 : 25: A clock generation machine, 29: A micro program controller, 31:aluminum, 32:anodization prevention layer, 33, 45:La Stampa, 34:indentation, 35:pore, 41:La Stampa material, 42:resist, 43:mask material, 44 : mask.

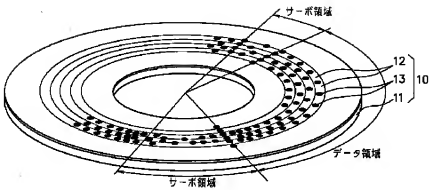
[Translation done.]

* NOTICES *

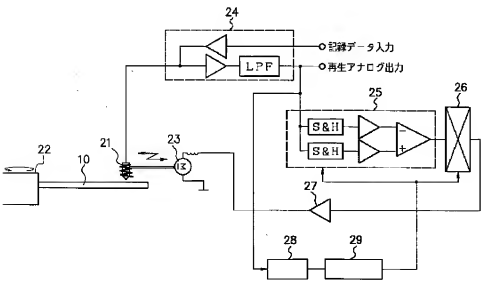
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

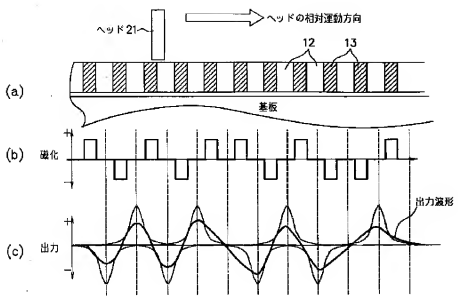
[Drawing 1]



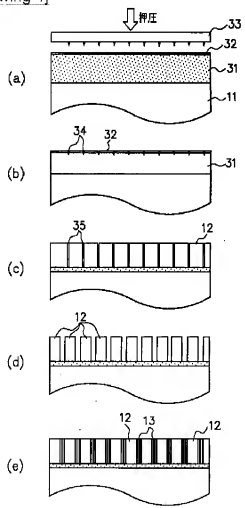
[Drawing 2]



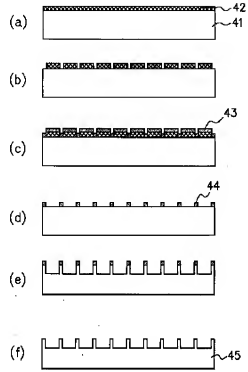
[Drawing 3]



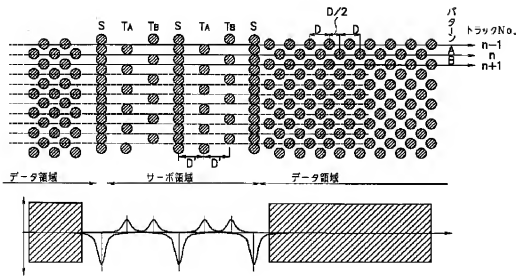
[Drawing 4]



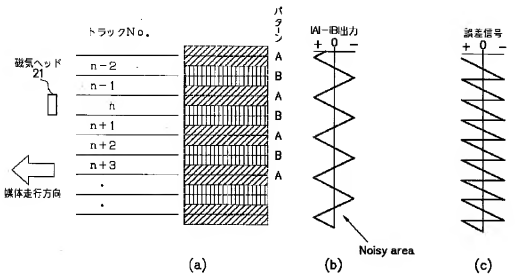
[Drawing 5]



[Drawing 6]



[Drawing 7]



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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to a magnetic recording medium which makes high density recording possible, and a manufacturing method for the same.

[0002]

[Description of the Prior Art]In order to position a record reproduction head correctly conventionally on the record reproduction track arranged in the magnetic disk drive at much concentric circle shape, track follow-up control is indispensable. For a detailed vibration of a solid of revolution although in the case of a magnetic disk drive it is self-rec/play and media are not exchanged unlike an optical disc etc., when recording and playing information, or eccentricity (NRRO), Neither the recorded track nor the locus of the playback head which traces it serves as a perfect concentric circle, but produces a track gap.

[0003]It is difficult to realize heat distribution in a uniform device ideally, and the thermal expansion difference by a temperature gradient produces the position error of the head made into the purpose, and a track. In order to amend these, it is necessary to detect the physical relationship of the track on a head and a medium in real time, and it is necessary to perform positioning based on this information.

[0004]Conventionally, in the stage which created the magnetic disk drive first, using the head incorporated by the device on the medium which is not recorded at all based on the external datum reference, cover all the tracks and a position information signal is recorded, It was positioning by reproducing the position information concerned at the time of subsequent actual use, and detecting the physical relationship of the track on a head and a medium. The process of recording this information is called servo writing (Servo Signal Writing), and the positioning method at the time of actual use is called a data surface servo system.

[0005]If a disc-like medium is actually attached to a spindle, however it may attach with high precision, mechanical eccentricity will arise for a fitting error etc., but. In order for the track recorded by adopting such a position control system to serve as concentric circle shape mostly and to position using the information same at the time of record reproduction, There is no fear of the physical relationship of a head and a track shifting, mistaking the information on an adjoining (it is said that it is offtrack.) track, and reproducing, or carrying out overwrite of the information to the adjacent track already recorded.

[0006]

[Problem(s) to be Solved by the Invention]However, therefore, position information was made to occupy the part on the medium which should record information essentially, and there was a fault whose storage

capacity decreases. In order to enlarge memorizable capacity, when the storage area of position information was lessened, the accuracy of position information fell this time, the above-mentioned off-track became large, and there was a fault which cannot make track density high.

[0007]In order to increase the storage capacity per unit area, when it was going to raise linear recording density (storage density of the direction along a track), while the signal output fell for interference of recording magnetization and magnetization, there was a fault that noise increased and signal S/N fell for autocorrelation. When it was going to raise track density, it was difficult to assign much position information area, in order to raise the signal quality of position information, and to realize a bulk store.

[0008]The purpose of this invention can realize high linear recording density and track density simultaneously, and there is in providing a magnetic recording medium which can attain mass magnetic recording, and a manufacturing method for the same.

[0009]

[Means for Solving the Problem]In a magnetic recording medium with which it comes to arrange two or more tracks for record reproduction at concentric circle shape of the same center as a medium center in order to attain said purpose in this invention, A storage area of the minimum unit for record reproduction of each track consists of an isolated magnetic-substance-cells group embedded at a minute hole arranged by position of a layer which consists of a nonmagnetic material of a medium surface.

[0010]In order that each magnetic substance cells may operate as single domain particles which do not have a magnetic interference mutually according to said composition, Since a phenomenon in which fluctuation of magnetization by switched connection shifts from a position by magnetostatic combination of a magnetic material absolutely none does not occur, either and a nonlinear time gap cannot arise, while high recording density-ization is realizable, S/N is improvable by leaps and bounds.

[0011]In said magnetic recording medium, each track has a servo area which has arranged a servo signal for detecting a data area and a track position which record information, A magnetic-substance-cells group of said data area is arranged at equal intervals on a concentric circle, and a magnetic-substance-cells group of said servo area on a concentric circle from which the width of recording track shifted [on / a concentric circle of a magnetic-substance-cells group of said data area] half a pitch, According to the thing arranging by turns at intervals of two different kinds for every track which are not the integral multiples of an arrangement space of magnetic substance cells of said data area, and adjoin, a servo signal can be embedded using arrangement of some magnetic substance cells, and high recording density-ization can be realized more.

[0012]On the surface of a substrate of aluminum covered with an anodization preventing film with the thin surface as a manufacturing method of these magnetic recording media. A process of forcing La Stampa which comprised a hard and brittle material used as a male for obtaining predetermined shape, and providing a film fracture portion by an indentation in a position of said anodization preventing film, A method of consisting of a process of forming pore (stoma) in an indentation portion, a process, to which a path of said pore is expanded by etching, and a process of embedding a magnetic metal material by electroplating into said expanded pore can be used by anodizing a substrate of said aluminum and making it alumite.

[0013]An indentation group of a data area is arranged at equal intervals on a concentric circle as a male for obtaining said predetermined shape in this case, On a concentric circle from which the width of recording track shifted [on / a concentric circle of an indentation group of said data area] half a pitch, an indentation group of a servo area, A male which can form an indentation so that it may be arranged by turns at intervals

of two different kinds for every track which are not the integral multiples of an arrangement space of an indentation of said data area, and adjoin can be used.

[0014]In a manufacturing method mentioned above, after adhering conductive metal other than aluminum on a glass plate, a substrate which adheres aluminum 0.1 microns or more can be used.

[0015]In a manufacturing method mentioned above, after adhering conductive metal other than aluminum on a glass plate, metal of soft magnetism is adhered and a substrate which adheres aluminum 0.1 microns or more can be used after that.

[0016]NiFe can be used as metal of soft magnetism in this case. Ti, or Cr or Ta can be used as conductive metal other than aluminum. An insulator layer can be used as an anodization preventing film. A poorly soluble metal thin film can be used to an electrolysis solution further again as an anodization preventing film.

[0017]

[Embodiment of the Invention]They are the magnetic substance cells which drawing 1 shows an example of the embodiment of the magnetic recording medium of this invention, and 12 embedded 11 among the figure at the substrate, embedded it at the alumite layer, and embedded 13 at the alumite layer 12.

[0018]The magnetic substance cells 13 are arranged at an interval fixed to the circumferencial direction of this magnetic recording medium 10, and a concrete target at intervals of [fixed] a number - 10 nm of numbers (data pitch: D), and form data tracks. The magnetic recording medium of this invention arranges such data tracks on a concentric circle. However, in order to acquire a track position signal so that it may mention later, and to consider it as a servo area beforehand in some tracks, the group of the magnetic substance cells 13 which changed arrangement is arranged.

[0019]The magnetic substance cells 13 are iron, nickel and cobalt which have the diameter and the length of several times or more about a half mostly, or them of a data pitch cylindrical metallic magnetic substances used as the main ingredients, and For shape anisotropy, It is a perpendicular magnetic recording medium which there is an easy axis in the direction of a pillar, and has an easy axis in the direction vertical to a medium surface. It dissociates by the not less than several nanometers alumite layer 12 between magnetic-substance-cells 13 comrades, and each magnetic substance cells 13 are the magnetic particulates which a magnetic exchange interaction did not work but became independent.

[0020]The magnetic recording medium which drawing 2 shows the composition of a recording and reproducing device, and ten mentioned above among the figure, 21 -- a magnetic head and 22 -- a spindle and 23 -- as for a switching circuit and 27, a record reproduction circuit and 25 are [a clock generation machine and 29] micro program controllers a servo amplifier and 28 an error amplifier and 26 an actuator and 24.

[0021]The medium 10 is rotated via the spindle 22, and if the head 21 and the medium 10 maintain a minute gap and carry out relative motion, the magnetic substance cells 13 will pass through the bottom of the magnetic head 21. If it makes it correspond to information according to predetermined agreement to set the upward state in "1" and the downward state to "0" etc. and they changes the reversal to facing down [facing up / facing up or], for example from facing down at this time, the magnetizing direction of a magnetic body, The signal reproduced from the magnetic head 21 is detected in the form where the information was multiplied by the transfer function of the magnetic head 21.

[0022]As drawing 3 shows the relation of the magnetization shape and the reproducing output in this

invention and shows it in the figure (a), At the time of record reproduction, the magnetic head 21 by changing the magnetizing direction of each magnetic substance cells 13 by turns, as shown in the figure (b) since the medium 10 is approached and relative motion of the surface of the magnetic substance cells 13 is carried out, As a solid line shows, by electromagnetic induction, the output wave from the head 21 becomes the figure (c) with a waveform with the peak of positive/negative. In order to help an understanding to the figure (c), the output wave (solitary wave) in case only an adjoining flux reversal part exists independently was written together with the dashed line. The output wave (solid line) from the head 21 becomes what piled up these solitary waves. It is the same as that of the case of the conventional magnetic disk by performing suitable waveform processing for this regenerative waveform that information is restored.

[0023]If the size of the magnetic substance cells 13 shall be about 100 nm or less and the gap shall be not less than about several 10 nm in order to realize high density recording, the switched connection between the magnetic substance cells 13 will go out, and each magnetic substance cells 13 will operate as single domain particles. As a result, since fluctuation of the magnetization by the switched connection which was the cause of noise of the conventional magnetic recording medium is lost entirely, there is not only no increase in the noise which was an essential problem with densification conventionally, but the primary medium noise itself will be extinguished.

[0024]Although there was a phenomenon (NLTS) in which a flux reversal position similarly shifted from a position by magnetostatic combination of a magnetic material, in the conventional magnetic recording which used the continuation medium, In this invention, magnetization is independently, and since a flux reversal field becomes an alumite layer between magnetic substance cells, a nonlinear time gap cannot produce it. That is, while a magnetization cell becomes small and densification can be realized compared with the conventional magnetic recording, S/N will be improved by leaps and bounds.

[0025]Although the magnetic head for performing record reproduction to the minute magnetic substance cells 13 which were mentioned above needs to be minute similarly, Such a magnetic head forms the coil for magnetic-recording reproduction on the thin film which consists of electrical conducting materials, such as a metallic magnetic substance, and can constitute it by attaching this to the end of the head block which consists of insulating materials, such as alumina titanium carbide, etc.

[0026]After forming the thin anodization prevention layers 32, such as resist, in the surface of the substrate 11 which was able to do the surface portion with the smooth aluminum 31 at least as shown in drawing 4 (a) in order to manufacture the magnetic recording medium mentioned above, La Stampa 33 which put the needlelike projection in order in the predetermined pitch beforehand is pressed, and as shown in drawing 4 (b), the trace 34 of detailed unevenness is formed in the surface. In a portion with concavo-convex marks, the anodization prevention layer 32 fractures and it becomes a form which metallic Al exposes. If the aluminum 31 is anodized within electrolysis solutions, such as oxalic acid and chromic acid, the alumina layer formed by anodization will grow considering a crevice as a center.

[0027]Since a hydrogen channel for an electrolysis solution to permeate at the time of anodization, and for the hydrogen generated deaerate remains in a crevice as shown in drawing 4 (c), this channel also grows with growth of alumina and it becomes the pore 35 (minute stoma). The alumina membrane (alumite) 12 in which thin pore was located in a line with the position of the crevice created to the beginning is formed in a substrate face after the end of anodization.

[0028]Thus, the formed pore is several nanometer diameter, and even if the thickness of an anodization

prevention layer is large, it usually hardly changes.

[0029]If this pore is dipped into a phosphoric acid solution, as shown in drawing 4 (d), the portion of pore will be expanded by etching. After an etching process, if metaled electrolytic plating is performed to the alumite surface, metal plating will be performed into the pore expanded as shown in drawing 4 (e). Then, if the surface is ground, the smooth film of the form where metal was embedded into the pore of alumina will be made.

[0030]As opposed to the alumina membrane in which this was anodized being an insulating material electrically, The bottom of pore is because the electrode metal which sends the current for anodizing remains when the material with another portion into which the metal of a base material remains, for example, anodization is not advancing when the substrate is made of aluminum, for example, a substrate, is glass. Actually, by anodization, since surface relative roughness deteriorates compared with an early smooth side, finally the surface is ground, the weld slag of the protective films, such as diamondlike carbon, is further carried out on it, a lubricating treatment is given, and it is considered as a magnetic disk.

[0031]Many researches and development are already made, and it is publicly known to alumite-ize the surface, to expand the pore, to embed a metallic magnetic substance, and to consider it as a medium. Even when it anodizes in the state where La Stampa is not pressed first, this pore is formed, but since that generated position is governed by the first oxidation starting position produced at random, it is [the positional interval in the surface of pore] also publicly known. [of becoming random naturally] As a result, when alumite-ization was performed without depending on this invention, the medium with independent magnetic body particle-like magnetic substance cells could be formed, but the physical relationship of pore was unable to make each magnetic substance cells themselves a storage unit from a random thing.

[0032]In order to create such a medium, La Stampa with the shape which serves as a male of the shape concerned beforehand is created, and it is widely known for substrate manufacture of optical disk media, etc. that what is necessary is to press against a substrate and just to carry out transfer creation of the female die. However, processing that each cell size made into the purpose of this invention in the process of the master / La Stampa manufacture by the light beam exposure/development to the conventional resist, and NiP plating is set to 100 nm or less is difficult.

[0033]As this invention shows to drawing 5 (a), as the La Stampa material 41 beforehand Then, silicon nitride (SiN), After applying the resist 42 and forming a pattern for this resist 42 by electron beam (EB) exposure on it using hard and brittle materials, such as amorphous carbon (drawing 5 (b)), the mask materials 43, such as SiO_2, are formed (drawing 5 (c)).

[0034]From the mask 44 of a predetermined pattern remaining on the La Stampa material 41 by dissolving the resist 42 (drawing 5 (d)). The La Stampa material 42 can be etched by reactive etching (RIE) etc. (drawing 5 (e)), and La Stampa 45 of the very detailed pattern made in the hard and brittle material can be created by finally dissolving the mask material 43 (drawing 5 (f)).

[0035]It is possible to form magnetic substance cells at the fixed interval on the circumference correctly with the accuracy of electron beam exposure in this invention, and it is also easy to arrange magnetic substance cells in arbitrary positions. Then, it is also possible to embed the track servo signal by the magnetic substance cells for distinguishing the track position on a concentric circle by using the technical feature of this invention. The track with which only data tracks and a half have at least two kinds of patterns in the specific field on the circumference after the track pitch has shifted is realizable for this by arranging by turns.

[0036]That is, as shown in drawing 6, the servo pattern of A and B-2 kind is arranged to some fields (servo area) of each track (track with which the track pitch shifted from each data tracks only the half strictly). The sink bit S provided common [a servo pattern] to the patterns A and B here. It consists of the timing bits TA and TB in which the distance from this sink bit S is provided in a position which is different to every patterns A and B, respectively, and is read by a magnetic head, respectively, and a pulse signal as shown in the lower half part of drawing 6 is generated.

[0037]Since the size of the amplitude of this pulse signal is proportional to the width of the magnetic substance cells which a magnetic head detects, if the magnetic head is tracing the center of data tracks correctly, the amplitude of two signals generated to the timing which changes with timing bits TA and TB will become equal, but. When a magnetic head shifts from the center position of a track, by this gap, the amplitude of the signal of the direction where the width which a magnetic head traces became large becomes large, and the amplitude of the signal of another side becomes small.

[0038]The timing which the signal by the timing bits TA and TB on the basis of generating of the signal by the sink bit S generates, It is decided by distance from the sink bit S to the timing bits TA and TB, and since it is known beforehand, position information is acquired by comparing the amplitude of the signal by the timing bits TA and TB to such timing.

[0039]In the device shown in drawing 2, specifically by the clock generation machine 28 and the program controller 29 from the regenerative signal of the record reproduction circuit 24. The sink bit S is extracted based on the difference of a bit interval with the data bit and servo bit (the sink bit S mentioned above and the timing bits TA and TB) which are mentioned later, By carrying out the gate of the two sample hold circuits (S&H) in the error amplifier 25 to the timing corresponding to each of timing bits TA and TB on the basis of this, The signal by the timing bits TA and TB can be taken out out of a regenerative signal, and the error signal (|A|-|B| output) of such signal amplitude (|A|, |B|) as shown in drawing 7 (b) can be taken out.

[0040]It is written in the data tracks by the magnetic substance cells 13 like the case of a well-known magnetic disk drive, If the polarity of the output of the error amplifier 25 is changed by the switching circuit 26 according to the parity of the track number reproduced in the record reproduction circuit 24, The offtrack error signal output whose off-track and error signal always become zero in a track center and become a linear relation (the direction of a track gap and the polarity of an error signal are in agreement in each track) as shown in drawing 7 (c) is obtained.

[0041]The position of a head and a track can be made to always agree correctly by controlling a head position by the servo amplifier 27 so that this error may become small.

[0042]Although the distinction with a data bit and a servo bit can be understood by monitoring the angle of rotation of the magnetic disk decided beforehand, Since the interval D of the data bit is determined very correctly in this invention, if it differs from a data bit, for example, pattern interval D' of the servo bit is made into 1.2 times - 1.8 times of a data bit, Since it turns out that it is an interval which is the record reproduction of data and is not acquired, it is distinguishable by this.

[0043]It uses that this differs from all the cycles of the pulse signal which is not a reason with required being less than twice at all, and is generated with the various patterns of data, and can identify by considering it as the interval which is not an integral multiple of a data bit. In order to be able to treat the magnetic substance cells for generating a servo signal in isolation to make storage density high, necessity becomes [a servo

area / many] by taking widely with a larger interval, for example, D'=4.5D, but a higher-precision servo signal is acquired.

[0044]In the conventional thin film medium, since the magnetization transition part might change with the recorded states in front and behind and intersymbol interference of information for the exchange interaction of a magnetic film and the stream shift might be caused, even if intervals differed, were not able to declare that it is not generally data, but. In this invention, since it has decided on the place which records information beforehand by making magnetic substance cells, it becomes possible.

[0045]As mentioned above, although the example using aluminum as a substrate explained, aluminum may be formed after providing metal layers, such as Ti for performing anodization and electroplating, Cr, and Ta, on it using a actual more hard and smooth glass substrate etc. At this time, what is necessary is just a grade which makes and puts the length of the magnetic substance cells which an indentation can transfer the thickness of aluminum correctly and are eventually made into the purpose, and when the diameter of magnetic substance cells is 50 nm and a data bit interval is about 100 nm, there should just be a thickness of about several 100 nm.

[0046]If soft magnetism metal, such as NiFe, is used for a metal layer, it will also be known that magnetic head sensitivity in vertical recording can be made high, As for the characteristic, what was alumite-ized using as a substrate what provided soft magnetism layers, such as NiFe, on metal layers, such as Ti for controlling the magnetic properties of a NiFe layer and Cr, and formed the aluminum layer by vacuum evaporation or a sputtering technique further on the glass plate actually is the best.

[0047]In this invention, as mentioned above, the layer which prevents anodization was provided in the surface, and pore former other than a predetermined place is controlled, but it is for preventing an oxidation start at places other than a position, and an anodization prevention layer hopes that there is nothing, when change of a cell interval made into the purpose is small.

[0048]SiO_2 and Si_3N_4 which are easily crushed by the La Stampa press besides resist since electrochemical reaction is only inhibited, About 10 nm of insulating films, such as diamond like carbon, may be used, and electrochemical potentials, such as Au and Pt, may use a poorly soluble metal thin film for an electrolysis solution by positive compared with hydrogen.

[0049]When an insulator layer is used for an anodization prevention layer, it does not wait for argument that electrochemical reaction arises only in the portion which aluminum exposed by press of La Stampa. In this case, since electric field concentrates are produced when there is an extreme interval change while truth and a current energizing surface product are small, and anodization current is small and ending, it is necessary to perform current density adjustment finely.

[0050]When a metal thin film is used for an anodization prevention layer, electric field distribution is uniform, and electrolysis arises even in a metal thin film surface, but pore which was mentioned above since there was no penetration from the surface to the aluminum of oxygen is not constituted, but magnetic substance cells can be formed only in a position.

[0051]

[Effect of the Invention]As stated above, according to this invention, the possible magnetic disk drive of very high-density information storage is cheaply and easily realizable. When this supports the considerable development of the information society which makes mass information storage necessary, it is not only important, but the deployment of new information use of it is attained.

[Translation done.]